HEIGHT OF THREE HARDWOOD SPECIES GROWING ON MINE SITES COMPARED TO NATURAL CONDITIONS

KARA DALLAIRE, JEFF SKOUSEN, JAMIE SCHULER

JUNE 11, 2015
West Virginia largest coal producer in the Appalachian region

90 active surface mines in 2013

Over 30 million Mg coal

Sources: Bise, 2013; U.S EIA, 2014
WV Forests

78% Eastern deciduous forests

Wood production

Ecosystem functions

Wildlife habitat

Source: Burger, 1999
Forestry Reclamation Approach

5 Steps:
1. Create suitable rooting medium
2. Do not compact
3. Use tree compatible ground cover
4. Plant at least two types of trees
5. Use proper planting techniques

Source: Burger et al., 2005
Brown vs. Gray Sandstone

Brown = 😊
Lower pH
Lower EC
> Fines

Sources: Angel et al., 2006; Burger et al., 2005; Conrad et al., 2008; Haering et al., 2004; Skousen et al., 2011; Daniels and Amos, 1984; Rodrigue and Burger, 2004
Amendments Improve Growth!

Sources: Angel et al., 2008; Emerson et al., 2009; Sena et al., 2014; Showalter et al., 2009; Thomas and Skousen, 2011; Wilson-Kokes, 20013a and 2013b
Tree Height (ft.)

Age (years)

GOOD Site
Average Site
POOR Site

Site Index = 105 ft.
Site Index = 85 ft.
SI = 65 ft.

Relative $ Value per acre: 1x
Relative $ Value per acre: 4x
Relative $ Value per acre: 8x

Source: Burger et al.
Methods

Two mine sites in WV
  ◦ Birch River
  ◦ Catenary

Yearly tree growth and soil samples collected

Data from Fernow Experimental Forest
  ◦ Two studies

Web Soil Survey
  ◦ Calculate pre-mine SI
Birch River

Established in 2007

Brown

Gray

Mulch
Catenary

Established in 2005

Brown Gray
Fernow Experimental Forest

Smith (1983)
- Clear-cut with release
- Tulip poplar
- Northern red oak
- SI 75
- SI 62

Trimble (1973)
- Clear-cut without release
- Tulip poplar
Site Index on Mine Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Northern red oak SI</th>
<th>White oak SI</th>
<th>Tulip poplar SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birch</td>
<td>78</td>
<td>78</td>
<td>92</td>
</tr>
<tr>
<td>River</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catenary</td>
<td>78</td>
<td>85</td>
<td>95</td>
</tr>
</tbody>
</table>

Source: USDA, 2014b
Average Site Index

Forest productivity (SI) from Web Soil Survey
Weighted average of soil types on sites
Formulation equation

\[ H = b_1 S^{b_2} (1-e^{b_3 A})^{b_4} S^{b_5} \]

H = Height
bi = Regression Parameters
S = Site Index
A = Age

Sources: Carmean et al., 1989; USDA, 2014b
<table>
<thead>
<tr>
<th>Birch River – brown sandstone</th>
<th>BR-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catenary – brown sandstone</td>
<td>C-B</td>
</tr>
<tr>
<td>Birch River – gray sandstone</td>
<td>BR-G</td>
</tr>
<tr>
<td>Catenary – gray sandstone</td>
<td>C-G</td>
</tr>
<tr>
<td>Birch River – mulch</td>
<td>BR-M</td>
</tr>
<tr>
<td>Clear-cut with release – SI 62</td>
<td>CR-62</td>
</tr>
<tr>
<td>Clear-cut with release – SI 75</td>
<td>CR-75</td>
</tr>
<tr>
<td>Clear-cut without release</td>
<td>CC</td>
</tr>
<tr>
<td>Pre-mining – Birch River</td>
<td>PBR</td>
</tr>
<tr>
<td>Pre-mining – Catenary</td>
<td>PC</td>
</tr>
<tr>
<td>Treatment</td>
<td>pH</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>BR-B</td>
<td>5.2</td>
</tr>
<tr>
<td>C-B</td>
<td>5.4</td>
</tr>
<tr>
<td>BR-G</td>
<td>6.5</td>
</tr>
<tr>
<td>C-G</td>
<td>6.8</td>
</tr>
<tr>
<td>BR-M</td>
<td>7.0</td>
</tr>
<tr>
<td>Fernow</td>
<td>4.1 to 5.2</td>
</tr>
<tr>
<td>PB</td>
<td>4.6 to 4.7</td>
</tr>
<tr>
<td>PC</td>
<td>4.7 to 4.9</td>
</tr>
<tr>
<td>Treatment</td>
<td>Ca</td>
</tr>
<tr>
<td>-----------</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>cmolₖ/kg</td>
</tr>
<tr>
<td>BR-B</td>
<td>6</td>
</tr>
<tr>
<td>C-B</td>
<td>7</td>
</tr>
<tr>
<td>BR-G</td>
<td>6</td>
</tr>
<tr>
<td>C-G</td>
<td>10</td>
</tr>
<tr>
<td>BR-M</td>
<td>197</td>
</tr>
</tbody>
</table>
Tulip poplar

Graph showing the growth of Tulip poplars over time. The x-axis represents tree age in years, ranging from 0 to 14. The y-axis represents height in centimeters, ranging from 0 to 1400. Different lines and markers represent various populations or genotypes of Tulip poplars, such as BR-B, BR-G, BR-M, PBR, C-B, C-G, PC, CR-75, CR-62, and CC. The graph highlights the growth patterns and differences among these populations.
Tree Growth

Trees growing on mines
Not original productivity
Limitations to height estimates
Weeds, animal and insect damage, stock quality, planting techniques

Sources: Beck and Trousdell, 1973; Carmean, 1975; Carmean et al., 1989
Conclusions

Birch River > Catenary

Brown sandstone > gray

Mulch increases growth

Tulip poplar:
- Brown and mulch > clearcut
Acknowledgements

Paul Ziemkiewicz (WVU)

Scott Eggerud (US OSM)

John McHale, Mitch Kalos, Jonathon Sanchez, Jeff Andrews (Patriot Coal)

Keith O’Dell, Bill Young, Mike Duvall (Arch Coal)

Paul Emerson, Curtis Delong, Calene Thomas, Lindsey Wilson-Kokes (former WVU grad students)

Steffany Scagline (WVU)


